Advanced Reusable Transportation Technologies Project

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The primary goal of the Advanced Reusable Transportation Technology (ARTT) project is to reduce by a factor of 100 over today's costs the payload transportation cost to low-Earth orbit by maturing technologies beyond X–33 for medium class launch vehicles (fig. 12). In doing so, the project's technology goals focus on combined cycle rocket-based propulsion systems and advanced materials (e.g., structures, tankage and TPS). These rocket-based combined cycle (RBCC) engines transition from an initial air-augmented rocket mode takeoff to ramjet mode, then to a scramjet mode and finally to an all rocket mode for orbital insertion.

The state-of-the-art all rocket single stage to orbit vehicle must have approximately 90 percent propellant and 10 percent inert mass. This inert mass must include the vehicle structure, propulsion hardware and the vehicle's payload. Modern operational engines, such as the SSME and the RD–0120, are essentially at the technical limit of rocket propulsion; further technology gains will only increase rocket performance (Isp) slightly. The use of RBCC propulsion may provide Isp gains of approximately 50 to 150 sec. These types of increases in mission average Isp would result in doubling the allowable launch vehicle inert mass fraction available for launch vehicle design. This additional margin could be utilized as increased operating margin by making the design more robust or to reduce the overall launch vehicle size. Either or both of these approaches would directly contribute to a major reduction in both operational costs and cost of payload to orbit.

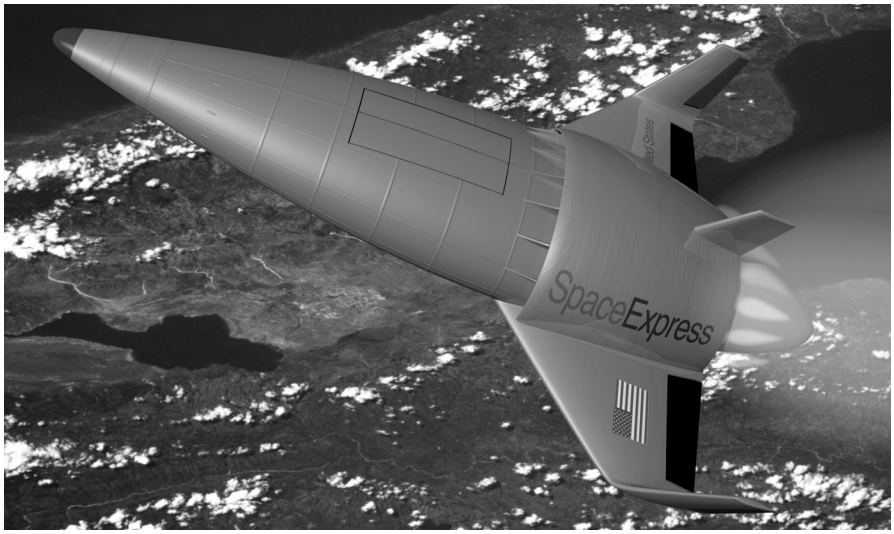

Figure 12.—Artist's concept of RBCC flying through atmosphere.

The ARTT project currently in progress focuses on ground testing those technologies deemed critical for the successful demonstration of an RBCC engine. Attention is being focused on the ability to design, fabricate, install and demonstrate small rockets in a carrying structure. These rockets will be required for the initial takeoff and low-speed operation of the launch vehicle. The rockets will then be turned off as the engine transitions to ramjet and scramjet modes. The rockets will finally be turned back on and the engine inlet closed for orbital insertion. The results of this testing will be incorporated with flow path work currently ongoing. The engines will be subscale, on the order of 1/6 scale, and will be flight-like but not flight-weight. Tests will include direct connect and freejet testing of these rockets in various test facilities, both industrial and government, in this country.

The incorporation of a supercharging fan increases the operability of a RBCC vehicle by adding a self-ferrying capability and additional abort-mode option. Technology issues associated with a supercharging fan will be addressed and tested in the ARTT project.

A large percentage of the launch vehicle cost reduction goal will be achieved by incorporation of RBCC propulsion. However to achieve a 1/100 reduction in the vehicle recurring cost, additional technologies will be required. Along with the RBCC technologies, advanced vehicle technologies will also be pursued. The main focus of this activity will be on primary structures, cryogenic tankage and thermal protection systems, and avionics.

Sponsor: Office of Aeronautics and Space Transportation Technology

Biographical Sketch: Jim Turner is the chief engineer for the Advanced Reusable Transportation Technologies Project. He holds a bachelor's degree in chemical engineering and a master of materials engineering from Auburn University, and has worked for MSFC for 14 years.